NIOSH/OSHA STANDARDS COMPLETION PROGRAM

DRAFT TECHNICAL STANDARD AND

SUPPORTING DOCUMENTATION FOR

*** CARBON DISULFIDE ***

NIOSH/OSHA Draft Technical Standard and Supporting Documentation for CARBON DISULFIDE

The basic text of this document contains the draft technical standard approved by the Joint Review Committee of the NIOSH/OSHA Standards Completion Program and the supporting documentation for the substance CARBON DISULFIDE.

The SCP draft technical standards are recommendations to the Department of Labor for its consideration in rulemaking and have no legal status until final rules have been promulgated by that agency. This draft standard is provided for your information only.

The References and Sources, Respirator Table Documentation and Use/Exposure and Control Documentation are the working documents used by the various SCP working groups during the development of the draft technical standard and serve as the technical foundation for the standard. The classification for each substance and the regulatory statements were derived following a decision logic established for the various sections of the standard.

NIOSH/OSHA Draft Technical Standard
and Supporting Documentation for CARBON DISULFIDE

(a) Definitions. (1) "Permissible exposure" means exposure of employees to airborne concentrations of carbon disulfide not in excess of 20 parts of carbon disulfide per million (ppm), averaged over an eight-hour work shift. In addition, 30 ppm shall not be exceeded during an eight-hour work shift, except that a peak of 100 ppm is permitted for 30 minutes during the eight-hour work shift, as stated in $ 1910.1000. Table Z-2.

(2) "Action level" means one-half of the permissible exposure for carbon disulfide averaged over an eight-hour work shift.

(b) Initial determination and exposure measurement. (1) Each employer who has a place of employment in which carbon disulfide is released into the workplace air shall determine if there is any possibility that any employee may be exposed to airborne concentrations of carbon disulfide above the permissible level. The initial determination shall be made each time there is a change in production, process, or control measures which may result in an increase in airborne concentrations of carbon disulfide.

(2) A written record of the initial determination shall be made and shall contain at least the following information:

(i) Any information, observations, or calculations which may indicate employee exposure to carbon disulfide;

(ii) Any measurements of carbon disulfide taken;

(iii) Any employee complaints of symptoms which may be attributable to exposure to carbon disulfide; and

(iv) Date of initial determination, work being performed at the time, location within work site, and employees considered.

(3) If the employer determines that any employee may be exposed to carbon disulfide above the permissible exposure, the exposure of the employee in each work operation who is believed to have the greatest exposure shall be measured. The exposure measurement shall be representative of the maximum eight-hour time weighted average exposure of the employee.

(4) If the exposure measurement taken pursuant to paragraph (b) (3) of this section reveals employee exposure to carbon disulfide above the action level, the employer shall:

(i) Identify all employees who may be exposed above the permissible level; and

(ii) Measure the exposure of the employees so identified.

(5) If an employee exposure measurement reveals that an employee is exposed to carbon disulfide above the action level, but not above the permissible exposure, the exposure of that employee shall be measured at least every three months.

(6) If an employee exposure measurement reveals that an employee is exposed to carbon disulfide above the permissible exposure, the employer shall:

(i) Measure the exposure monthly of the employee so exposed; and

(ii) Institute control measures as required by paragraph (d) of this section; and

(iii) Individually notify, in writing, within five days, every employee who is found to be exposed to carbon disulfide above the permissible exposure. The employee shall also be notified of the results of the exposure measurements and of the corrective action being taken to reduce the exposure to below the permissible exposure.

(7) If two consecutive employee exposure measurements taken at least one week apart reveal that the employee is exposed to carbon disulfide below the action level, the employer may terminate measurement for the employee.

(8) For purposes of this paragraph, employee exposure is that which would occur if the employee were not using a respirator.

(c) Methods of measurement. (1) An employee's exposure shall be obtained by any combination of long term or short term samples which represents the employee's actual exposure averaged over an eight-hour work shift (See Appendix B (IV) of this section).

(2) The method of measurement shall have an accuracy, to a confidence level of 95 percent, of not less than that given in Table 1.

Table 1

Concentration	Required Accuracy
Above permissible exposure	± 25%
At or below permissible exposure and above the action level	± 35%
At or below the action level	± 50%

(d) Compliance. (1) No employee shall be exposed to carbon disulfide above the permissible exposure as defined in paragraph (a)(1) of this section.

(2) Employee exposures to airborne concentrations of carbon disulfide shall be controlled to at or below the permissible exposure by engineering and work practice controls:

(i) Engineering and work practice controls shall be instituted to reduce exposures to at or below the permissible exposure, except to the extent that such controls are not feasible.

(ii) Wherever engineering and work practice controls are not sufficient to reduce exposures to at or below the permissible exposure, they shall nonetheless be used to reduce exposure to the lowest level feasible and shall be supplemented by respirators in accordance with paragraph (d)(4) of this section.

(3) Engineering controls. (i) When local exhaust is used to control exposure, measurements which demonstrate system effectiveness, for example, air velocity or static pressure, shall be made at least every three months. Measurements of system effectiveness shall also be made within five days of any change in production, process, or control which might result in an increase in airborne concentrations of carbon disulfide.

(ii) In the design of open surface tank ventilation for the purposes of § 1910.94(d), operations involving carbon disulfide shall be classified as B-1 at 21 degrees C (70 degrees F).

(4) Compliance with the permissible exposure shall not be achieved by the use of respirators except:

(i) During the time period necessary to install or implement engineering or work practice controls; or

(ii) In work situations in which engineering and work practice controls are not feasible; or

(iii) To supplement engineering and work practice controls when such controls fail to reduce airborne concentrations of carbon disulfide to at or below the permissible exposure; or

(iv) For operations which require entry into tanks or closed vessels; or

(v) In emergencies.

(5) Where respirators are needed and permitted under this paragraph to reduce employee exposure, the employer shall select and provide the appropriate respirator from Table 2 and shall ensure that the employee uses the respirator provided.

TABLE 2 RESPIRATORY PROTECTION FOR CARBON DISULFIDE

CONDITION	PERMISSIBLE RESPIRATORY PROTECTION
Vapor Concentration	
200 ppm or less	Any chemical cartridge respirator with an organic vapor cartridge(s). Any supplied-air respirator. Any self-contained breathing apparatus.
500 ppm or less	A chemical cartridge respirator with a full facepiece and organic vapor cartridge(s). A gas mask with a chin-style or a front- or back-mounted organic vapor canister. Any supplied-air respirator with a full facepiece, helmet or hood. A Type C supplied-air respirator operated in pressure - demand or other positive pressure or continuous-flow mode. Any self-contained breathing apparatus with a full facepiece.
Greater than 500 ppm or entry and escape from unknown concentrations	Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode. A combination respirator which includes a Type C supplied - air respirator with a full facepiece operated in pressure - demand or other positive pressure or continuous-flow mode and an auxiliary self-contained breathing apparatus operated in pressure-demand or other positive pressure mode.

Fire Fighting	Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode.
Escape	Any gas mask providing protection against organic vapors. Any escape self-contained breathing apparatus.

(6) Respirators shall be approved by the Mining Enforcement and Safety Administration (formerly Bureau of Mines) or by the National Institute for Occupational Safety and Health under the provisions of 30 CFR Part 11.

(7) The employer shall institute a respiratory protection program in accordance with § 1910.134(b), (d), (e), and (f).

(e) Fire and safety. (1) The employer shall familiarize himself with the information contained in the Substance Technical Guidelines (Appendix B of this section) for carbon disulfide.

(2) No electrical installations shall be permitted in carbon disulfide areas.

(3) For the purpose of compliance with § 1910.157, carbon disulfide is classified as a Class B fire hazard, except that foam fire extinguishing media shall not be used.

(4) For the purpose of compliance with § 1910.106, liquid carbon disulfide is classified as a Class IB flammable liquid.

(5) Dip tank operations shall be performed in accordance with §§ 1910.108 and 1910.94(d).

(6) Where a fan is located in ductwork and where carbon disulfide is present in the ductwork in concentrations greater than 3500 ppm (approximately 25% of the lower flammable limit), the fan rotating element shall be of nonsparking material or the casing shall consist of, or be lined with, nonsparking material. There shall be sufficient clearance between the fan rotating element and the fan casing so as to prevent contact.

(7) Sources of ignition such as smoking or open flames are prohibited where carbon disulfide is handled, used, or stored.

(8) Carbon disulfide shall be stored so as not to come in contact with sunlight, strong oxidizers, chemically active metals, azides and organic amines.

(9) Non-sparking tools shall be used to open and close containers of carbon disulfide.

(f) Personal protective equipment. (1) Employers shall provide and ensure that employees use appropriate protective clothing and equipment necessary to prevent skin contact with liquid carbon disulfide, where skin contact may occur. Face shields shall comply with § 1910.133(a)(2),(a)(4), (a)(5), and (a)(6).

(2) Employers shall ensure that clothing wet with liquid carbon disulfide is placed in closed containers for storage until it can be discarded or until the employer provides for the removal of carbon disulfide from the clothing. If the clothing is to be laundered or otherwise cleaned to remove the carbon disulfide, the employer shall inform the person performing the operation of the hazardous properties of carbon disulfide.

(3) Employers shall ensure that non-impervious clothing which becomes contaminated with carbon disulfide be removed promptly and not reworn until the carbon disulfide is removed from the clothing.

(4) Employers shall ensure that clothing which becomes wet with liquid carbon disulfide be removed immediately and not reworn until the carbon disulfide is removed from the clothing.

(5) Employers shall provide and ensure that employees use splash-proof safety goggles which comply with § 1910.133(a)(2)-(a)(6) where liquid carbon disulfide may contact the eyes.

(g) Spills and disposal. (1) In the event that liquid carbon disulfide is spilled the employer shall immediately eliminate potential sources of ignition, provide available ventilation and then clean up the spill.

(2) Liquid carbon disulfide shall not be allowed to enter a confined space, such as a sewer, because of the possibility of an explosion. Sewers designed to preclude the formation of explosive concentrations of vapors are permitted.

(h) Sanitation. Employers shall ensure that employees whose skin becomes contaminated with carbon disulfide promptly wash or shower with soap or mild detergent and water to remove any carbon disulfide from the skin.

(i) Training and information. (1) Each employer who has a workplace in which carbon disulfide is present shall keep a copy of this regulation with Appendixes A, B and C at the workplace. This material shall be made readily available to affected employees.

(2) Each employer who has employees exposed to carbon disulfide above the action level without regard to the use of respirators, or employees who may have skin or eye contact with liquid carbon disulfide, or employees who work where carbon disulfide presents a fire or explosion hazard, shall annually:

(i) Inform affected employees of the information contained in the Substance Safety Data Sheet for carbon disulfide (Appendix A of this section);

(ii) Advise affected employees as to the signs and symptoms of exposure to carbon disulfide.

(iii) Instruct affected employees to advise the employer of the development of signs and symptoms of overexposure to carbon disulfide which are listed in Appendix A of the section;

(iv) Provide training to ensure that employees understand the precautions of safe use, emergency procedures, and the correct use of protective equipment relative to carbon disulfide.

(j) Medical surveillance. (1) The employer shall provide medical procedures as required by this paragraph. All medical procedures shall be performed by or under the supervision of a physician at no cost to the employee.

(2) Preplacement medical examination. The employer shall make available to each employee who is exposed, or will be exposed, to airborne concentrations of carbon disulfide above the action level, without regard to the use of respirators, or employees who may have skin or eye contact with liquid carbon disulfide a preplacement medical examination which must include the following:

(i) A medical history and physical examination with emphasis on the central and peripheral nervous systems, eyes, heart, kidneys, liver and skin;

(ii) Eye examination to include visual acuity test;

(iii) Urinalysis to include specific gravity, albumin, glucose and a microscopic on centrifuged sediment;

(iv) A profile of liver function;

(v) An electrocardiogram.

(3) Periodic medical examination. The employer shall make available to each employee exposed to airborne concentrations of carbon disulfide above the action level, without regard to the use of respirators, or employees who may have skin or eye contact with liquid carbon disulfide twelve months from the date of the employee's first exposure, and every twelve months thereafter, a periodic medical examination which must include the following:

(i) A medical history and physical examination with emphasis on the central and peripheral nervous systems, eyes, heart, kidneys, liver and skin;

(ii) Eye examination to include visual acuity test;

(iii) Urinalysis to include specific gravity, albumin, glucose and a microscopic on centrifuged sediment;

(iv) A profile of liver function;

(v) An electrocardiogram.

(4) Alternative medical procedures. If the examining physician chooses to use alternative medical procedures to those specified in paragraphs (j)(2) and (j)(3) of this section, the employer may accept such alternative medical procedures as meeting the requirements of this section provided that the employer:

(i) Obtains a statement from the examining physician setting forth the alternative medical procedures, the rationale for substitution, and evidence that they will be equally effective;

(ii) Informs each exposed worker of the fact that alternative medical procedures to those required in paragraphs (j)(2) and (j)(3) of this section are to be made available.

(5) Interim medical examination. The employer shall provide an interim medical examination employee if the employee informs the employer of any of the signs or symptoms of exposure to carbon disulfide which are listed in Appendix A which the employee suspects are caused by exposure to carbon disulfide.

(6) Informing the physician. The employer shall provide to the physician performing any medical examination required by this section the following information:

(i) A copy of this regulation with Appendixes A, B, and C for carbon disulfide;

(ii) A description of the affected employee's duties as they relate to his exposure to carbon disulfide;

(iii) A description of any personal protective equipment and respirators required to be used;

(iv) The results of any measurements which may indicate the affected employee's exposure;

(v) The affected employee's anticipated exposure level; and

(vi) Upon request of the physician, any available information from previous medical examinations of the affected employee.

(7) Where a medical examination is required by paragraphs (j)(2), (j)(3), or (j)(5) of this section, following such examination the employer shall obtain from the examining physician a written opinion which conforms with paragraph (j)(8) of this section.

(8) Physician's written opinion. (i) The physician's written opinion by the examining physician shall specifically state:

(A) Whether the employee has any detected medical condition which would place the employee at increased risk of material impairment of the employee's health from exposure to carbon disulfide;

(B) Any recommended limitations upon the employee's exposure to carbon disulfide, including limitations upon the use of personal protective equipment and respirators;

(C) That the employee has been informed by the physician of any detected medical conditions which require further medical examination or treatment.

(ii) The physician's written opinion shall not reveal specific medical findings or diagnoses unrelated to the employee's employment.

(iii) The employer shall provide the employee with a copy of the physician's written opinion.

(9) Results of tests. Where a preplacement or periodic medical examination is required by paragraphs (j)(2) or (j)(3) of this section, following such examination the employer shall obtain from the examining physician for inclusion in the employee's medical record:

(i) A recording of the results of the eye examination, urinalysis, liver function tests, and electrocardiogram reading;

(ii) Where alternative medical procedures have been performed in accordance with paragraph (j)(4) of this section, a recording of such alternative procedures.

(10) No employee shall be exposed to carbon disulfide in such a way as would put the employee at increased risk of material impairment of his health from such exposure. The employer shall base this decision on any information available including the physician's written opinion.

(11) No medical procedure which would be performed pursuant to paragraphs (j)(2) or (j)(3) of this section need be performed if records of a previous such procedure performed within the past six months are acceptable to the examining physician.

(12) If an employee refuses any required medical examination, the employer shall inform the employee of the possible health consequences of such refusal and obtain a signed statement from the employee indicating that the employee understands the risk involved by refusal to be examined.

(13) The employer shall provide emergency medical treatment for any employee injured through exposure to carbon disulfide.

(k) RecordKeeping. (1) Exposure determination. (i) The employer shall keep an accurate record of all determinations required to be made pursuant to paragraph (b)(1) of this section.

(ii) This record shall include the written determination required in paragraph (b)(2) of this section.

(iii) This record shall be maintained until replaced by a more recent record.

(2) Exposure measurements. (i) The employer shall keep an accurate record of all measurements taken to determine employee exposure to carbon disulfide.

(ii) This record shall include:

(A) The date of measurement;

(B) Operations involving exposure to carbon disulfide which are being monitored;

(C) Sampling and analytical method used and evidence of their accuracy;

(D) Number, duration, and results of samples taken; and

(E) Name, social security number and exposure of the employee monitored.

(iii) This record shall be maintained until replaced by a more recent record but in no event for less than one year.

(3) Mechanical ventilation. (i) When mechanical ventilation is used as an engineering control, the employer shall maintain an accurate record of the measurements demonstrating the effectiveness of such ventilation required by paragraph (d)(3) of this section.

(ii) This record shall include:

(A) Date of measurement;

(B) Type of measurement taken;

(C) Result of measurement.

(iii) These records shall be maintained for at least one year.

(4) Employee training and information. (i) The employer shall keep an accurate record of all employee training and information required by paragraph (i) of this section.

(ii) This record shall include:

(A) Date of training;

(B) Name and social security number of employee trained;

(C) Content or scope of training provided.

(iii) This record shall be maintained until replaced by a more recent record.

(5) Medical surveillance. (i) The employer shall keep an accurate record of employee medical surveillance required by paragraph (j) of this section.

(ii) This record shall include:

(A) The name and social security number of the employee;

(B) Results of tests required by paragraph (j)(2) and (j)(3) of this section and results of any tests conducted pursuant to paragraphs (j)(4) of this section;

(C) Any employee medical complaints relative to exposure to carbon disulfide;

(D) A copy of information provided to the physician pursuant to paragraph (j)(6)(ii), (iii), (iv), (v), and (vi) of this section.

(E) Physician's written opinion; and

(F) A signed statement of any refusal to be examined.

(iii) This record shall be maintained for the duration of and for five years after termination of the employment of the affected employee.

(6) Access to records. (i) All records required to be maintained by this section shall be made available upon request to authorized representatives of the Assistant Secretary of Labor for Occupational Safety and Health and the Director of the National Institute for Occupational Safety and Health.

(ii) Each employee or former employee shall have access to the exposure determination and exposure measurement records required to be maintained by this section which indicate his own exposure to carbon disulfide.

(iii) Employee medical records required to be maintained by this section shall be made available upon written request to a physician designated by the employee or former employee.

(l) Employee observation of measurement. (1) The employer shall give each employee or his representative an opportunity to observe any measurement of his exposure to carbon disulfide which is conducted pursuant to this section.

(2) When observation of measurement of employee exposure to carbon disulfide requires entry into an area where the use of personal protective devices, including respirators, is required, the observer shall be provided with and required to use such equipment and comply with all other applicable safety procedures.

(3) Without interfering with the measurement, observers shall be entitled to:

(i) Receive an explanation of the measurement procedure.

(ii) Visually observe all steps related to the measurement of the airborne concentration of carbon disulfide that are being performed at the place of exposure; and

(iii) Record the results obtained.

NOTE: The information contained in the following appendix for carbon disulfide is neither intended, by itself, to create any additional obligations not otherwise imposed, nor detract from any existing obligation. To the extent that the information supplements this regulation for carbon disulfide, it is advisory in nature.

APPENDIX A

SUBSTANCE SAFETY DATA SHEET FOR CARBON DISULFIDE

I. SUBSTANCE IDENTIFICATION

A. Substance: Carbon disulfide

B. Permissible Exposure: 20 parts of carbon disulfide per million parts of air (ppm) averaged over an eight-hour workshift. In addition, 30 ppm shall not be exceeded during an eight-hour work shift, except that a peak of 100 ppm is permitted for 30 minutes during the eight-hour work shift.

C. Appearance and Odor: Colorless to faintly yellow liquid with a strong, disagreeable or sweetish odor

II. HEALTH HAZARD DATA

A. Ways in which the chemical affects your body: Carbon disulfide can affect your body if you inhale it or if it

comes in contact with your eyes or skin or if you swallow it. It may enter your body through your skin.

C. Effects of Overexposure:

1. Short-term Exposure: Inhalation of carbon disulfide vapor may cause headache, nausea, drop in blood pressure, dizziness, unconsciousness and death. Liquid carbon disulfide and high concentrations of the vapor may cause irritation of the skin, eyes and nose. If the liquid is trapped under clothing it may cause a burn. Swallowing carbon disulfide may cause loss of consciousness and convulsions. If small amounts are swallowed only vomiting, diarrhea and headache may occur.

2. Long-term Exposure: Prolonged or repeated exposure to carbon disulfide may damage the nervous system with muscle weakness, numbness, feelings of pins and needles, unsteady walking and difficulty in swallowing. Palsy, speech difficulty and muscle spacticity may also occur. In addition, memory loss, headache, difficulty sleeping, nervousness, fatigue, irritability, depression, suicidal tendencies and psychosis may occur. Eye damage may occur with such symptoms as blind spots, narrowing of vision and decreased ability to see in the dark. Increased arteriosclerosis may occur which may cause or increase damage to the heart and other organs. High blood pressure, kidney damage, liver damage and stomach problems may occur. Repeated or prolonged exposure of the skin to carbon disulfide may cause a skin rash.

3. Reporting Signs and Symptoms: You should inform your employer if you develop any signs or symptoms and suspect that they are caused by exposure to carbon disulfide.

III. EMERGENCY FIRST AID PROCEDURES

A. Eye Exposure: If liquid carbon disulfide gets into your eyes, wash your eyes immediately with large amounts of water, lifting the lower and upper lids occasionally. If irritation persists after washing, get medical attention. Contact lenses should not be worn when working with this chemical.

B. Skin Exposure: If liquid carbon disulfide gets on your skin, immediately wash the contaminated skin using soap or mild detergent and water. If liquid carbon disulfide soaks through your clothing, remove the clothing immediately and wash the skin using soap or mild detergent and water. Get medical attention promptly.

C. Breathing: If you or any other person breathes in large amounts of carbon disulfide move the exposed person to fresh air at once. If breathing has stopped, perform artificial respiration. Keep the affected person warm and at rest. Get medical attention as soon as possible.

D. Swallowing: When liquid carbon disulfide has been swallowed and the person is conscious, give the person large quantities of water immediately. After the water has been swallowed,

try to get the person to vomit by having him touch the back of his throat with his finger. Do not make an unconscious person vomit. Get medical attention immediately.

E. Rescue: Move affected person from the hazardous exposure. If the exposed person has been overcome, notify someone else and put into effect the established emergency rescue procedures. Do not become a casualty yourself. Understand your emergency rescue procedures and know the locations of the emergency rescue equipment before the need arises.

IV. RESPIRATORS AND PROTECTIVE CLOTHING

A. Respirators: Respirators are not the best way to control exposure to carbon disulfide. You can only be required to wear them for routine use if your employer is in the process of installing controls or control measures prove inadequate. You may be required to wear respirators for non-routine activities or in emergencies. If respirators are worn, they must have a Mining Enforcement and Safety Administration (MESA) or National Institute for Occupational Safety and Health (NIOSH) approval label. (Older respirators may have a Bureau of Mines approval label.) For effective protection, respirators must fit your face and head snugly. Respirators should not be loosened or removed in work situations where there use is required. If you experience difficulty breathing while wearing a respirator, tell your employer.

B. Protective Clothing: You must wear appropriate protective clothing and equipment to prevent skin contact with liquid carbon disulfide, where skin contact may occur. Replace or repair impervious clothing that has developed leaks.

C. Eye Protection: You must wear splash-proof safety goggles where liquid carbon disulfide may contact your eyes.

V. PRECAUTIONS FOR SAFE USE, HANDLING AND STORAGE

A. Carbon disulfide is a flammable liquid and its vapors can easily form explosive mixtures with air.

B. Carbon disulfide must be stored in tightly closed containers in a cool, well ventilated area away from sunlight, strong oxidizers, chemically active metals, azides and organic amines.

C. Sources of ignition such as smoking and open flames are prohibited wherever carbon disulfide is handled, used or stored.

D. You must use non-sparking tools when opening or closing containers of carbon disulfide, and metal containers must be bonded and grounded when pouring or transferring liquid carbon disulfide.

E. You must promptly remove any non-impervious clothing that becomes contaminated with carbon disulfide and this clothing must not be reworn until the carbon disulfide is removed from the clothing.

F. Clothing wet with liquid carbon disulfide can be easily ignited. You must immediately remove this clothing and it must not be reworn until the carbon disulfide is removed from the clothing.

G. If your skin becomes contaminated with carbon disulfide, you must promptly wash or shower with soap or mild detergent to remove the carbon disulfide from your skin.

H. Fire extinguishers, where provided, must be readily available and you should know where they are and how to operate them.

I. Ask your supervisor where carbon disulfide is used in your work area and for any additional safety and health rules.

VI. ACCESS TO INFORMATION

A. Each year your employer is required to inform you of the information contained in this Substance Safety Data Sheet for carbon disulfide. In addition, your employer must instruct you in the safe use of carbon disulfide, emergency procedures, and the correct use of protective equipment.

B. Your employer is required to determine whether you are being exposed to carbon disulfide. You or your representative have the right to observe employee exposure measurements and to record the results obtained. If your employer determines that you are being overexposed, he is required to inform you of the exposure and the actions which are being taken to reduce your exposure.

C. Your employer is required to keep records of your exposure and medical examinations. Your employer is required to keep exposure data for at least one year and to keep medical data during your employment, and for a period of five years following your termination of employment. Your employer is required to make the exposure data available to you upon your request. Your employer is also required to release your medical records to your physician upon your written request.

D. Your employer must give you a copy of the physicians written opinion for any physical examination required by this standard.

NOTE: The information contained in the following appendix for carbon disulfide is neither intended, by itself, to create any additional obligations not otherwise imposed, nor detract from any existing obligation. To the extent that the information supplements this regulation for carbon disulfide, it is advisory in nature.

APPENDIX B

SUBSTANCE TECHNICAL GUIDELINES FOR CARBON DISULFIDE

I. PHYSICAL AND CHEMICAL DATA

A. Substance Identification

1. Synonyms: Carbon bisulfide

2. Formula: CS2
3. Molecular weight: 76.1

B. Physical Data

1. Boiling point (760 mm Hg): 46.3 C (115 F)
2. Specific gravity (water = 1): 1.27
3. Vapor density (air = 1 at boiling point of carbon disulfide): 2.6
4. Melting point: -111.5 C (-169 F)
5. Vapor pressure at 20 C (68 F): 300 mm Hg
6. Solubility in water, % by weight at 20 C (68 F): 0.2
7. Evaporation rate (butyl acetate = 1): 22.6
8. Appearance and odor: Colorless to faintly yellow liquid with a strong, disagreeable or sweetish odor

II. FIRE, EXPLOSION AND REACTIVITY HAZARD DATA

A. Fire

1. Flash point: -30 C (-22 F) (closed cup)
2. Autoignition temperature: 90 C (194 F)
3. Flammable limits in air, % by volume: Lower: 1.3; Upper: 50.0
4. Extinguishing media: Dry chemical, carbon dioxide for small fires
5. Special fire-fighting procedures: Do not use a solid stream of water since a stream will scatter and spread the fire. Use water spray to cool containers exposed to a fire and to help prevent reignition by hot surfaces.
6. Unusual fire and explosion hazards: Carbon disulfide is a flammable liquid with a very low flash point. It can be ignited on contact with a steam line or an electric light bulb. Its vapors can easily form explosive mixtures with air. All ignition sources must be controlled where carbon disulfide is used, handled or stored. Carbon disulfide vapors are heavier than air and may travel along the ground and be ignited by open flames or sparks at locations remote from the site at which carbon disulfide is handled.
7. For purposes of conforming with the requirements of 29 CFR 1910.106, carbon disulfide is classified as a Class IB flammable liquid. For example, 3500 ppm, approximately one-fourth of the lower flammable limit, is one situation in which carbon disulfide is considered to be a potential fire and explosion hazard.

B. Reactivity

1. Conditions contributing to instability: Containers may burst when heated.
2. Incompatibilites: Contact with strong oxidizers, chemically active metals (such as sodium, potassium, and zinc), azides, and organic amines may cause fires and explosions.
3. Hazardous decomposition products: Toxic gases and vapors (such as sulfur dioxide and carbon monoxide) may be released in a fire involving carbon disulfide.

4. Special precautions: Liquid carbon disulfide will attack some forms of plastics, rubber and coatings.

III. SPILL, LEAK, AND DISPOSAL PROCEDURES

A. If carbon disulfide is spilled or leaked, the following steps should be taken:

1. Remove all ignition sources.
2. Ventilate area of spill or leak.
3. For small quantities, absorb on paper towels. Evaporate in a safe place (such as a fume hood). Allow sufficient time for vapors to completely clear hood ductwork, then burn the paper. Large quantities can be collected and reclaimed or atomized in a suitable combustion chamber equipped with an appropriate effluent gas cleaning device. Carbon disulfide must not be allowed to enter a confined space, such as a sewer, because of the possibility of an explosion. Sewers designed to preclude the formation of explosive concentrations of carbon disulfide vapors are permitted.

B. Persons not wearing protective equipment should be restricted from areas of spills or leaks until cleanup has been completed.

C. Waste disposal methods: Carbon disulfide may be disposed of by atomizing in a suitable combustion chamber equipped with an appropriate effluent gas cleaning device.

IV. MONITORING AND MEASUREMENT PROCEDURES

A. EXPOSURE ABOVE THE ACTION LEVEL:

1. Eight-Hour Exposure Evaluation: Measurements taken for the purpose of determining employee exposure under this section are best taken such that the eight-hour exposure may be determined from a single eight-hour sample or two four-hour samples. Several short-time interval samples (up to 30 minutes) may also be used to determine the average exposure level. Air samples should be taken in the employee's breathing zone (air that would most nearly represent that inhaled by the employee).
2. Ceiling Evaluation: Measurements taken for the purpose of determining employee exposure under this section must be taken during periods of maximum expected airborne concentrations of carbon disulfide in the employee's breathing zone. A minimum of three (3) measurements should be taken on one work shift and the highest of all measurements taken is an estimate of the employee's exposure.
3. Peak Above Ceiling Evaluation: Measurements taken for the puspose of determining employee exposure under this section must be taken during periods of maximum expected airborne concentration of carbon disulfide. Each measurement should consist of a (30 minute) sample or series of consective samples totaling (30 minutes) in the employee's breathing zone (air that would most nearly represent that inhaled by the employee). A minimum of three measurements should be taken on one

work shift and the highest of all measurements taken is an estimate of the employee's exposure.

4. Monitoring Techniques: The sampling and analysis under this section may be performed by instruments such as detector tubes certified by NIOSH under 42 CFR part 84, portable direct-reading instruments, dosimeters, or gas and vapor adsorption tubes with subsequent chemical analyses. The method of measurement must determine the concentration of carbon disulfide to plus or minus 35%.

B. EXPOSURE ABOVE THE PERMISSIBLE EXPOSURE: The monitoring and measurements under this section should be essentially the same as described under paragraph IV. A. When sampling for peak or ceiling exposure evaluations, more than three (3) measurements should be taken during the work shift so that increased confidence may be placed in the judgement that the employee has or has not, in fact, been exposed in excess of the permissible limit. Laboratories performing chemical analyses should be accredited in Industrial Hygiene Chemistry by the American Industrial Hygiene Association. The method of measurement must determine the concentration of carbon disulfide to plus or minus 25%.

C. METHODS: Methods meeting these accuracy requirements are available from the National Technical Information Service, U. S. Department of Commerce, Springfield, Virginia 22161 under the title "NIOSH Analytical Methods for Set R " (Order number XXXXXXXXXX).

D. QUALIFIED PERSONS: Since many of the duties relating to employee protection are dependent on the results of monitoring and measuring procedures, employers should assure that the evaluation of employee exposures is performed by a competent industrial hygienist or other technically qualified person.

V. MISCELLANEOUS PRECAUTIONS

A. Store carbon disulfide in tightly closed containers in a cool, well ventilated area.

B. High exposures to carbon disulfide can occur when transferring the liquid from one container to another.

C. Non-sparking tools must be used to open and close carbon disulfide containers. Metal containers must be effectively grounded and bonded prior to pouring and transferring.

D. Cover carbon disulfide in partially filled containers with water. Transfer carbon disulfide from one container to another by pressure of water or carbon dioxide, never by air.

E. Employers should advise employees of all areas and operations where their exposure to carbon disulfide could occur.

VI. COMMON OPERATIONS

Common operations in which exposure to carbon disulfide is likely to occur are: During its production and its use as a solvent for oils, sulfur, phosphorus, and the paraffin gums that clog oil wells; as an intermediate in the manufacture of viscose rayon, cellophane, carbon tetrachloride, thiocyanates, and rubber accelerators; during pesticide application; and during the manufacture of optical glass.

NOTE: The information contained in the following appendix is neither intended, by itself, to create any additional obligations not otherwise imposed, nor detract from any existing obligation. To the extent the information supplements this regulation for carbon disulfide, it is advisory in nature.

APPENDIX C - MEDICAL SURVEILLANCE GUIDELINES

I. ROUTE OF ENTRY

Inhalation; skin absorption.

II. TOXICOLOGY

Carbon disulfide vapor causes narcosis at high concentrations; repeated exposure to low concentrations causes damage to the central and peripheral nervous systems and may accelerate the development of or worsen coronary heart disease. Exposure of humans to 1150 ppm causes serious symptoms and 4800 ppm for 30 minutes may be fatal. Carbon disulfide intoxication can involve all parts of the central and peripheral nervous systems including damage to the cranial nerves and development of polyneuritis with paresthesias and muscle weakness in the extremities, unsteady gait, and dysphagia. In extreme cases of intoxication, a Parkinson-like syndrome may result, characterized by speech disturbances, muscle spasticity, tremor, memory loss, mental depression, and marked psychic symptoms; permanent disability is likely. Psychosis and suicide are established risks of overexposure to carbon disulfide. Other reported effects of exposure to carbon disulfide are ocular changes (blind spot enlargement, contraction of peripheral field, corneal anesthesia, diminished pupillary reflexes, nystagmus, microscopic aneurysms in the retina), gastrointestinal disturbances (chronic gastritis and achlorhydria), renal impairment (albuminuria, microchematuria, elevated blood urea nitrogen, diastolic hypertension), and liver damage. Effects commonly caused by repeated exposure to carbon disulfide vapor are exemplified by a group of workers with a time-weighted average (TWA) exposure of 11.2 ppm (range 0.9 to 127 ppm) who complained of headaches and dizziness; in other workers with a TWA of 186 ppm (range 23 to 378 ppm) complaints also included sleep disturbances, fatigue, nervousness, anorexia, and weight loss; the end of day exposure coefficient of the iodine azide test on urine was a good indicator of workers who were or had been symptomatic. Overexposure to carbon disulfide has long been regarded as potentially atherogenic for cerebral, renal and coronary arteries; recent epidemiologic studies of viscose rayon workers have confirmed a 2.5 to 5 fold increase in risk of death from coronary heart disease as compared with the experience of unexposed workers. Other cardiovascular effects observed in workers repeatedly exposed to carbon disulfide are bradycardia, tachycardia, other arrhythmias, and electrocardiographic changes consistent with both nonspecific and ischemic wave changes. Splashes of the liquid in the

eyes cause immediate and severe irritation; dermatitis and vesiculation may result from skin contact with the vapor or the liquid. Although ingestion is unlikely to occur, it may cause coma and convulsions.

III. SIGNS AND SYMPTOMS

Dizziness, headaches, sleep disturbances, fatigue, nervousness, anorexia, weight loss; psychosis; polyneuritis; Parkinson-like syndrome; ocular changes including enlargement of blind spot, contraction of peripheral field of vision, diminished pupillary reflexes; coronary heart disease, diastolic hypertension; cardiac arrhythmias; gastritis; signs of kidney and liver damage; eye and skin burns from splashes; dermatitis.

IV. SPECIAL TESTS

The iodine-azide reaction with urine is useful in estimating exposure to carbon disulfide. Approximately 70 percent of the carbon disulfide retained in the body is metabolized and excreted in urine as organic sulfates or other sulfur compounds like thiourea, thiocarbamide, and 5-mercaptothiazolidone. These metabolites are probably responsible for the iodine-azide reaction with the urine of exposed workers. It should be stressed that this analysis is not specific for carbon disulfide since other substances, which yield an increased excretion of bivalent sulfur, influence the reaction.

V. TREATMENT

Remove from exposure. Immediately flush eyes with water and wash skin with soap or mild detergent and water. If swallowed and the person is conscious, induce vomiting. Give artificial resuscitation and administer oxygen if indicated.

VI. SURVEILLANCE AND PREVENTIVE CONSIDERATIONS

A. GENERAL

Carbon disulfide damages the central and peripheral nervous system. It may cause an increase in incidence of coronary heart disease. It causes liver and kidney damage, cardiac arrhythmias, and diminished visual acuity. Skin absorption is known to occur. It is important that the physician become familiar with plant operating conditions in which exposure to carbon disulfide occurs. Those with skin disease may not tolerate the wearing of protective clothing and those with chronic respiratory disease may not tolerate the wearing of negative pressure respirators.

B. PREPLACEMENT

The following medical procedures must be made available to each employee who is exposed to carbon disulfide:

1. A complete history and physical examination -- The purpose is to detect preexisting conditions that might place the exposed employee at increased risk, and to establish a baseline for future health monitoring. Examination of the central and peripheral nervous systems, eyes, cardiovascular system, kidneys, and liver. The skin should be examined for evidence of chronic disorders.

2. Urinalysis -- Since kidney damage has been observed in humans exposed to carbon disulfide, an urinalysis shall be obtained to include at a minimum specific gravity, albumin, glucose and a microscopic on centrifuged sediment.

3. Liver function tests -- Since liver damage has been observed in humans exposed to carbon disulfide, a profile of liver function shall be obtained by using a medically acceptable array of biochemical tests.

4. An electrocardiogram -- Carbon disulfide has caused arrhythmias and electrocardiographic changes in humans. Periodic surveillance is indicated.

5. Ophthalmic examination -- Carbon disulfide has caused ocular changes in humans. An ophthalmic examination shall be performed including visual acuity.

C. PERIODIC EXAMINATIONS

The above medical examinations are to be repeated on an annual basis.

VII. REFERENCES

1. American Conference of Governmental Industrial Hygienists: "Carbon Disulfide," Documentation of the Threshold Limit Values for Substances in Workroom Air (3d ed., 2d printing), Cincinnati, 1974, pp. 39-40.

2. Davidson, M. and M. Feinleib: "Carbon Disulfide Poisoning: A Review," American Heart Journal, 83:100-114, 1972.

3. Zenz, C.: Occupational Medicine - Principles and Practical Applications, Year Book Medical Publishers, Chicago, 1975, pp. 801-804, 813-815.

4. Rosensteel, R.E., et al: "Occupational Health Case Report - No. 1," Journal of Occupational Medicine, 16:22-32, 1974.

5. Brieger, H.: "Chronic Carbon Disulfide Poisoning," Journal of Occupational Medicine, 14:123-124, 1972.

6. Graovac-Leposavic, L., et al: "The Use of the Iodine-Azide Test for the Early Diagnosis of Carbon Disulphide Poisoning," in H. Brieger and J. Teisinger, Eds., Toxicology of Carbon Disulfide - Proceedings, Excerpta Medica Foundation, Amsterdam, 1967, pp. 62-69.

7. Mancuso, T.F. and B.Z. Locke: "Carbon Disulphide as a Cause of Suicide - Epidemiological Study of Viscose Rayon Workers," Journal of Occupational Medicine, 14:595-606, 1972.

8. Hanninen, H.: "Psychological Picture of Manifest and Latent Carbon Disulfide Poisoning," British Journal of Industrial Medicine, 28:374-381, 1971.

9. Hernberg, S., et al: "Coronary Heart Disease among Workers Exposed to Carbon Disulphide," British Journal of Industrial Medicine, 27:313-325, 1970.

10. Tolonen, M.: "Vascular Effects of Carbon Disulfide, A Review," Scandinavian Journal of Work Environment and Health, 1:63-77, 1975.

11. Lieben, J., et al: "Cardiovascular Effects of CS2 Exposure," Journal of Occupational Medicine, 16:449-453, 1974.

12. World Health Organization: Early Detection of Health Impairment in Occupational Exposure to Health Hazards, Technical Report Series No. 571, Geneva, 1975, pp. 47-55.

13. Hygienic Guide Series: "Carbon Disulfide (Carbon Bisulfide)," American Industrial Hygiene Association Quarterly, 17:446-447, 1956.

14. Patty, Frank A.: Industrial Hygiene and Toxicology, Vol. II - Toxicology (2d ed. revised), Interscience Publishing Company, New York, 1963, pp. 901-904.

15. Browning, Ethel: Toxicity and Metabolism of Industrial Solvents, Elsevier Publishing Company, Amsterdam, 1965, pp. 702-712.

16. Manufacturing Chemists Association, Inc.: Chemical Safety Data Sheet SD-12, Carbon Disulfide, Washington, D.C., 1967, pp. 5-6, 14-15.

17. International Labour Office: Encyclopaedia of Occupational Health and Safety, Vol. I, A-K, McGraw Hill Book Company, New York, 1974, pp. 252-253.

18. National Institute of Health: Carbon Disulfide: Its Toxicity and Potential Dangers, Public Health Reports, 56:574-581, 1941.

19. Djuric, D., et al: "Iodine-Azide Test on Urine of Persons Exposed to Carbon Disulphide," British Journal of Industrial Medicine, 22:321-323, 1965.

20. Lauwerys, R.: "Biological Criteria for Selected Industrial Toxic Chemicals: A Review," Scandinavian Journal of Work Environment and Health, 1:139, 151, 162-163, 168, 170-171, 1975.

REFERENCES AND SOURCES
CARBON DISULFIDE
1910.1000

(d) Compliance - Open surface tank classification based on relative evaporation rate of 0.4 hours (from Doolittle)

(e) Fire and Safety

(1) Electrical - Classification based on "Fire Hazard Classification of Chemical Vapors Relative to Explosion-proof Electrical Equipment," National Academy of Sciences, 1975, report to U. S. Coast Guard, report no. IV under contract DOT-CG-41680-A.

(f) Personal Protective Equipment, and, (h) Sanitation

Eye: Grant, "Toxicology of the Eye;" Manufacturing Chemists' Association, Chemical Safety Data Sheets

Skin: Manufacturing Chemists' Association, Chemical Safety Data Sheets; ANSI, "American National Standard Acceptable Concentrations;" Thienes and Haley, "Clinical Toxicology;" AIHA Hygienic Guide Series; ACGIH, "Documentation of TLV's for Substances in Workroom Air;" Sax, "Dangerous Properties of Industrial Materials"

Ingestion: Sax, "Dangerous Properties of Industrial Materials;" Gleason, "Clinical Toxicology of Commercial Products;" Manufacturing Chemists' Association, Chemical Safety Data Sheets; Deichmann and Gerarde, "Toxicology of Drugs and Chemicals"

COMMENTS

Eye - Classification: 2
Output statement number: 10
Exceptions: None

The MCA reports that "splashes of liquid carbon disulfide in the eyes cause immediate and severe irritation."

Though Grant reviews in detail the effects on the eyes from systemic poisoning, no information is given as to the effects of direct contact with the liquid.

Since there are no data indicating that permanent injury occurs, the substance is assigned a classification of 2.

Skin - Classification: 2
Output statement numbers: 2, 7b, 17g, 17i, 21
Exceptions: See below

The MCA reports that "carbon disulfide dissolves fat and can remove it from skin causing dryness and cracking. If the liquid is allowed to evaporate, the acute effect may only be slight redness. If the liquid is trapped under clothing or shoes and not allowed to evaporate, it may lead to a chemical burn of the skin." The Hygienic Guide and others agree with this. Thienes and Haley add that blistering is common and that adjacent nerve fibers degenerate.

Sax considers it to be an acute local irritant of slight toxic hazard. By skin absorption, however, he considers its acute and chronic systemic effects to be of high toxic hazard.

Concerning skin absorption, the U. S. A. Standards Institute

notes that "liquid carbon disulfide penetrates the skin, but skin absorption is in general far less important in industry than absorption by inhalation of the vapor." The ACGIH reports that toxic quantities can be absorbed through the skin.

The vapor pressure of this substance is 300 mm Hg at 20 degrees C. It is 0.2% soluble in water and has a flash point of -22 degrees F.

A classification of 2 is concluded to be appropriate to prevent the effects cited. Because of the rapidity with which it appears to attack the skin, however, and since small amounts confined to the skin may cause severe burns, statement 2 is used to prevent contact where it "may occur" and statements 17g and 17i are used instead of 16g and 16i. Due to its high vapor pressure, however, statement 7b is used instead of 7a.

Ingestion - Classification: 0
Output statement numbers: None
Exceptions: None

The MCA reports that "small quantities by mouth may only cause vomiting, diarrhea and headache." Sax considers the chronic systemic effects of ingestion to be of high toxic hazard.

The effects of chronic intoxication listed by Sax and others include CNS effects and eye effects. Sax notes that "in chronic poisoning, the effect is one of central and peripheral damage, which may be permanent if the damage has been severe."

Gleason reports that half an ounce has killed on at least three occasions while 2 ounces failed to kill in another. Deichmann and Gerarde give the probable acute lethal dose as being 30 ml.

The considerable vapor pressure of this substance and the manner in which it attacks the skin lead to the conclusion that ingestion of harmful quantities, in the context of this standard, is unlikely in the industrial environment.

SUBSTANCE TECHNICAL GUIDELINES

The references cited for this document include:

National Fire Protection Association, "Fire Protection Guide on Hazardous Materials," 5th edition, 1975 (NFPA)

Manufacturing Chemists' Association, Chemical Safety Data Sheet SD-12 (MCA)

FMC Corp., "FMC Carbon Disulfide," "FMC Safety Regulation for CS2," "Oil Well Treatment with Carbon Disulfide," "Safe CS2 Handling and Unloading Procedures" (FMC)

Kirk-Othmer, "Encyclopedia of Chemical Technology," 1st edition, Vol. 12, p. 666 and 681 (K-O)

Sources of data items used:

I. A. 1. Synonyms: NFPA-325M, MCA
2. Formula: NFPA-49, MCA
3. Molecular weight: FMC

B. 1. Boiling point: NFPA-325M, MCA
2. Specific gravity: FMC
3. Vapor density: NFPA-325M, MCA

4. Melting point: MCA, FMC
5. Vapor pressure: MCA, FMC
6. Solubility in water: MCA, FMC
7. Evaporation rate: K-O
8. Appearance and odor: NFPA-49, FMC

II. A.
1. Flash point: NFPA-325M, MCA, FMC
2. Autoignition temperature: NFPA-325M
3. Flammable limits: NFPA-325M, MCA
4. Extinguishing media: NFPA-325M, MCA, FMC
5. Special fire fighting procedures: NFPA-325M, NFPA-49, FMC
6. Unusual fire and explosion hazards: NFPA-49, FMC

B.
1. Conditions contributing to instability: FMC
2. Incompatibilities: NFPA-491M
3. Hazardous decomposition products: MCA
4. Special precautions: ADL

III. A. Steps if released or spilled: MCA, ADL

C. Waste disposal method: NFPA-49, MCA

V. Miscellaneous precautions: NFPA-49, FMC

USE/EXPOSURE AND CONTROL DOCUMENT

The references used in the preparation of this document include:

Browning, E., "Toxicity and Metabolism of Industrial Solvents," Elsevier Publishing Co., 1965 (Browning)

"Carbon Disulfide," American Conference of Government Industrial Hygienists, Hygienic Guide Series, April 1964 (Hygienic Guides)

"Carbon Disulfide," Chemical Engineering, 2/18/74, p. 125 (Chem Eng)

"Carbon Disulfide," Hygienic Information Guide No. 64, Commonwealth of Pennsylvania, Department of Environmental Resources, Bureau of Occupational Health, 11/72 (Penn)

Hamilton, A. and Hardy, H. L., "Industrial Toxicology," Publishing Sciences Group, Inc., 3rd edition, 1974 (Hamilton and Hardy)

International Labour Organization, "Encyclopedia of Occupational Health and Safety," Geneva, 1972 (ILO)

Kirk, R. and Othmer, D., "Encyclopedia of Chemical Technology," Interscience Publishers, Division of John Wiley, 2nd edition, 1972 (K-O)

Lefaux, R., "Practical Toxicology of Plastics," The Chemical Rubber Co., Cleveland, 1968 (Lefaux)

Patty, F. A., "Industrial Hygiene and Toxicology," Vol. II, Interscience Publishers, 1962 (Patty)

Rosensteel, R. E., Shama, S. K. and Flesch, J. P., "Occupational Health Case Report - No. 1 - Carbon Disulphide Viscose Rayon Manufacture," Journal of Occupational Medicine, 16:22 - 30, 1974 (Rosensteel)

Spector, W. S., et al. - editors, "Handbook of Toxicology," Saunders, Philadelphia, 1956 - 1959 (Spector)

Stanford Research Institute, "Chemical Economics Handbook," Menlo Park, California (SRI)

Stanford Research Institute, "Chemical Origins and Markets," SRI, Menlo Park, 1967 (Chem Origins)

U. S. Environmental Protection Agency, Office of Pesticide Programs, "EPA Compendium of Registered Pesticides - Vol. III - Insecticides, Acaricides, Molluscicides and Antifouling Compounds," GPO, 1972 (EPA)

References for Specific Use/Exposure

1. Rosensteel, Lefaux, Patty

2. SRI, K-O
3. ADL estimate
4. EPA, Spector
5. SRI, K-O
6. ADL estimate
7. Chem Origins, K-O
8. Patty
9. Patty, ILO, Browning
10. Lefaux
11. K-O, Chem Origins
12. ILO, Chem Eng, Hamilton and Hardy
13. Chem Eng, K-O
14. Chem Eng

References for Specific Control Methods

1. Rosensteel, Lefaux, Hygienic Guides
2. Penn, Hygienic Guides and ILO were the references used in numbers 2 - 14 of the Specific Control Methods.

RESPIRATOR TABLE DOCUMENTATION

SUBSTANCE: Carbon disulfide

D. O. L. STANDARD: 20 ppm, where 30 ppm shall not be exceeded, except that a peak is permitted of 100 ppm for 30 minutes during an eight-hour work shift

WARNING PROPERTIES:

Odor Threshold: The Handbook of Organic Industrial Solvents states that at less than 1 ppm, carbon disulfide has a disagreeable odor. Summer gives an odor threshold of 7.7 ppm , and Staub gives 0.0011 ppm and 0.0081 ppm. The AIHA Hygienic Guides give an odor threshold of 1.2 ppm.

Eye Irritation Level: Carbon disulfide is not known to be an eye irritant.

Evaluation of Warning Properties: Since the odor threshold of carbon disulfide is below the permissible exposure limit, carbon disulfide is treated as a material with good warning properties. Gas sorbent respiratory equipment is permitted.

IDLH: 500 ppm

Basis for IDLH Value: This IDLH is based upon the report in Patty that "symptoms (occur) after 1/2 hour" at 420 - 510 ppm carbon disulfide. The AIHA Hygienic Guides point out that "severe symptoms and unconsciousness may occur within half an hour at 1,100 ppm." Zenz reported that exposure of humans to 4800 ppm for 30 minutes causes coma and may be fatal.

Other Toxicological Information: According to the Documentation of TLV's, "carbon disulfide vapor is absorbed largely through the lungs, although toxic quantities can also be absorbed through the skin. Its effects are mostly on the nervous system; single exposures are characterized by narcosis and its sequelae. Symptoms of repeated exposure are nervousness, irritability, indigestion, bizarre dreams leading to insomnia, excessive fatigue, loss of appetite and headache."

Patty states that "the table below lists six representative levels of effect upon man, with corresponding ranges of concentration inhaled carbon disulfide . . . The possibility of injury to the central nervous system from a single severe acute exposure is reported by Lewy."

Effects of Various Concentrations of

Carbon Disulfide on Man

Effects	Concentration mg/liter	Concentration ppm
Slight or no effect	0.5 - 0.7	160 - 230
Slight symptoms after several hours	1.0 - 1.2	320 - 390
Symptoms after 1/2 hour	1.5 - 1.6	420 - 510
Serious symptoms after 1/2 hour	3.6	1150
Dangerous to life after 1/2 hour	10.0 - 12.0	3210 - 3850
Fatal in 1/2 hour	15.0	4815

The Documentation of TLV's report that "Wiley and co-workers exposed animals repeatedly at 37 ppm and found significant toxic effects. They recommended that concentrations be maintained below 32 ppm. It is now recognized that the neural responses to CS2 are greatly influenced by the mineral content of the diet, at least in animals a highly mineralized diet offering substantial protection.

"The limit of 20 ppm, although protecting against serious systemi effects, would appear to have little margin of safety, especially for those with mineral-deficient diets."

LFL: 13,000 ppm
VAPOR PRESSURE AT 20 C: 300 mm Hg
SATURATED CONCENTRATION AT 20 C: Approximately 395, 000 ppm

Zenz, C.: Occupational Medicine - Principles and Practical Applications, Year Book Medical Publishers, Chicago, 1975, p. 902.

NIOSH/OSHA Draft Technical Standard
and Supporting Documentation for CARBON DISULFIDE

USE/EXPOSURE AND CONTROL DOCUMENT
CARBON DISULFIDE

	Use/Exposure	Principal Route of Entry	Currently Used Control Methods
1.	Inhalation of vapor and skin contact with liquid and vapor during xanthation of cellulose and spinning and cutting operations in manufacture of viscose rayon	A,B,D	Process enclosure; local exhaust ventilation; general dilution ventilation; temperature control; personal protective equipment (air-supplied respirator, goggles, protective clothing)
2.	Inhalation of vapor and skin contact with liquid and vapor during use as a xanthating agent in manufacture of cellophane	A,B,D	Process enclosure; local exhaust ventilation; general dilution ventilation; temperature control; personal protective equipment (air-supplied repirator, goggles, protective clothing)
3.	Inhalation of vapor and skin contact with liquid and vapor during synthesis and handling of substance	A,B,D	Process enclosure; local exhaust ventilation; general dilution ventilation; temperature control; personal protective equipment (air-supplied repirator, goggles, protective clothing)
4.	Inhalation of vapor and skin contact with liquid and vapor during pesticide application by spray and fumigation (including soil treatment, fumigation of commodities such as grains, and space fumigation of agricultural premises)	A,B,D	Process enclosure; local exhaust ventilation; general dilution ventilation; temperature control; personal protective equipment (air-supplied repirator, goggles, protective clothing)
5.	Inhalation of vapor and skin contact with liquid and vapor during synthesis of carbon tetrachloride	A,B,D	Process enclosure; local exhaust ventilation; general dilution ventilation; temperature control; personal protective equipment (air-supplied repirator, goggles, protective clothing)
6.	Inhalation of vapor and	A,B,D	Process enclosure; local

	skin contact with liquid and vapor during manufacture and handling of pesticides		exhaust ventilation; general dilution ventilation; temperature control; personal protective equipment (air-supplied repirator, goggles, protective clothing)
7.	Inhalation of vapor and skin contact with liquid and vapor during synthesis of intermediates and manufacture of dyes, pharmaceuticals, rubber chemicals, flotation agents and pesticides (including trichloromethylsulfenyl chloride, thiocarbanilide, and dithiocarbamates)	A,B,D	Process enclosure; local exhaust ventilation; general dilution ventilation; temperature control; personal protective equipment (air-supplied repirator, goggles, protective clothing)
8.	Inhalation of vapor and skin contact with liquid and vapor during production as a by-product during destructive distillation of coal (including manufacture of coal gas and distillation of coal tar)	A,B,D	Process enclosure; local exhaust ventilation; general dilution ventilation; temperature control; personal protective equipment (air-supplied repirator, goggles, protective clothing)
9.	Inhalation of vapor and skin contact with liquid and vapor during manufacture of optical glass	A,B,D	Process enclosure; local exhaust ventilation; general dilution ventilation; temperature control; personal protective equipment (air-supplied repirator, goggles, protective clothing)
10.	Inhalation of vapor and skin contact with liquid during use as a solvent in dry spinning of polyvinylchloride	A,B,D	Process enclosure; local exhaust ventilation; general dilution ventilation; temperature control; personal protective equipment (air-supplied repirator, goggles, protective clothing)
11.	Inhalation of vapor and skin contact with liquid during use as a solvent in oil wells	A,B,D	Process enclosure; local exhaust ventilation; general dilution ventilation; temperature control;

			personal protective equipment (air-supplied repirator, goggles, protective clothing)
12.	Inhalation of vapor and skin contact with liquid during rubber manufacture (including cold curing operations)	A,B,D	Process enclosure; local exhaust ventilation; general dilution ventilation; temperature control; personal protective equipment (air-supplied repirator, goggles, protective clothing)
13.	Inhalation of vapor and skin contact with liquid during extraction processing (including oils, fats, resins, waxes, phosphorous)	A,B,D	Process enclosure; local exhaust ventilation; general dilution ventilation; temperature control; personal protective equipment (air-supplied repirator, goggles, protective clothing)
14.	Inhalation of vapor and skin contact with liquid or vapor during manufacture of matches	A,B,D	Process enclosure; local exhaust ventilation; general dilution ventilation; temperature control; personal protective equipment (air-supplied repirator, goggles, protective clothing)

A -- Inhalation
B -- Skin and eye contact resulting in localized irritation
C -- Ingestion
D -- Skin contact resulting in absorption and subsequent systemic poisoning